Objective 7.1 Conduct research to develop and evaluate on-farm intervention strategies or technologies

- Peter S. Holt
- Southeast Poultry Research Lab
- 934 College Station Road
- Athens, Georgia 30605
- U.S.A.

Forced molting and other stress factors

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Why Molt?

"Since the early 1970's, the amount of flock recycling (induced molting) in the U.S. has doubled. Today, it is estimated that approximately 60 percent of the nation's laying flocks are recycled compared to 90 percent or more in California."

Donald Bell

Poultry Tribune, May 1987

Approximately 240 million layers in U.S.

↓ 60-70%

144-168 million layers molted annually

Benefits of molt

- Increased productivity
- Increased feed conversion
- Less mortality than unmolted counterparts (*although not always*)
- Equals rest from rigor of constant egg lay

Ways to molt

- Low sodium
- High zinc
- Drugs
- Feed/nutrient restriction
- Feed removal - 25-30% weight loss

Molting Procedure

- Acclimatize birds 7 days
- Light set to 8 hours/day
- Remove feed 14 days
- Start back on grower ration
- Gradually increase light period

Molt effects immunity

- No effect humoral immunity
- Depressed cell mediated immunity
  - delayed hypersensitivity
  - graft vs host
  - lymphocyte blastogenesis
- Decreased CT4+ T cells

Importance of good immune system

Vaccine response

Fight disease

Viral

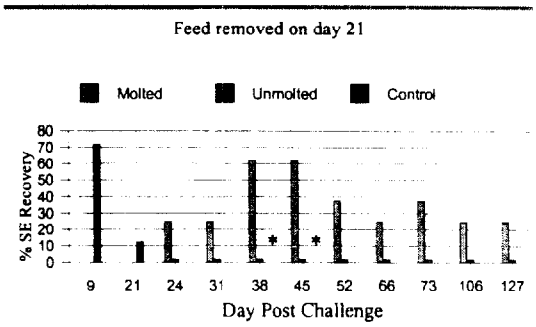
Bacterial

Salmonella enteritidis

Molting effects on SE infection

- Infection during molt
  - More SE released
  - More birds stay infected longer periods
- Infection before molt
  - Normal (fed) birds generally eliminate SE after certain time
  - Certain number molted birds remain infected for very long periods
  - Hen 79

Molt effects on previous SE infection



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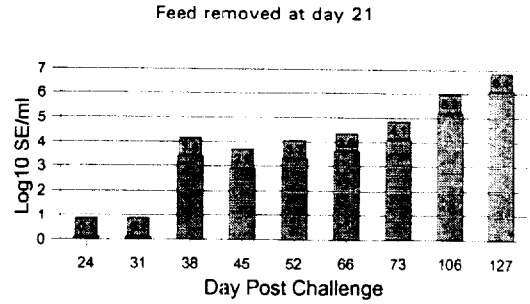
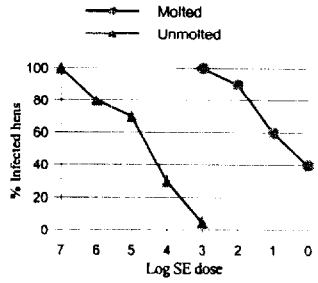
SE Shedding by Hen 79



Molting effects on SE infection (cont)

- Increased susceptibility to SE
  - Over 5 X 10^4 SE needed to infect fed birds
  - Less than 10 SE needed to infect molted birds
- Rapid transmission to uninfected birds
  - Little transmission (at SE doses used) in normal (fed birds)
  - High transmission of SE - more than 80% of exposed birds infected by day 10

Molt vs susceptibility to SE



Why might this be a problem?

Susceptible to SE in house

- Environment & workers
  - Stringent biosecurity important
- Rodents
  - Can shed up to 10^5 SE/fecal pellet
  - Are amplifiers of SE problem
- Other hens
  - 12-15% infected birds in a flock

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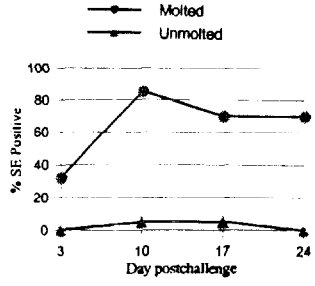
Molt vs horizontal transmission of SE



Molting & Production of SE+ Eggs

Week	% SE+ Eggs
20-16 Premolt	0.057
15-11 Premolt	0.006
10-6 Premolt	0.017
5-0 Premolt	0.024
0-5 Postmolt	0.144
6-10 Postmolt	0.029
11-15 Postmolt	0.013

From USDA/ARS SE Pilot Project, 1994

Possible causes of SE problems during molt

- Immune depression
- Depression of innate immunity
- Alteration of intestinal microflora
- Effects on peristalsis/digesta cleansing action

Possible solutions for molt problems

- Alternative molt
  - Molt diet
  - Skip feed molt
  - Low nutrition/lower energy feed alternatives
    - *Wheat middlings*
    - Soybean hulls
    - Cracked corn
- Antibiotic therapy
- Vaccination

Molt diet vs fasting

- SE shed rate unaffected
- Levels of SE shed decreased toward control levels
  - Important for transmission
  - Important for disinfection & clean up
- Used metered amount of feed - less acceptable by industry

Holt et al Poultry Science 73:1267-75, 1994

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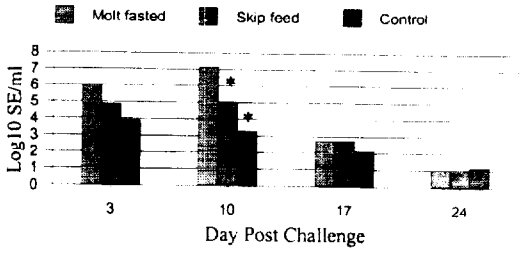
Skip Feed Molting Procedure

(Courtesy of Dr. Ikuo Eguchi, IKN Poultry)

- Light period 10 hours
- Birds off feed for 6 days
- Alternate 3 days on grower feed and 1 day off for four cycles
- After last day off feed, birds put on layer feed and light increased to 13 hours

Skip feed vs fasting on SE infection



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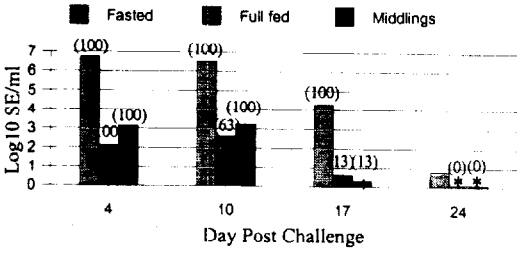
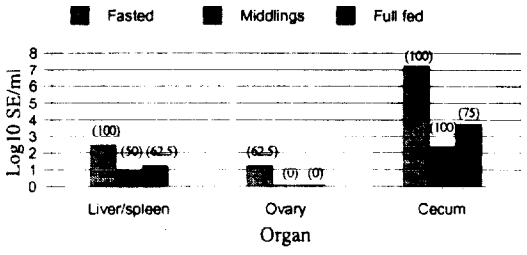
Wheat middlings vs fasting on gut SE infection

Experiment 1



Wheat middlings vs fasting on SE infection in internal organs - day 7

Experiment 1



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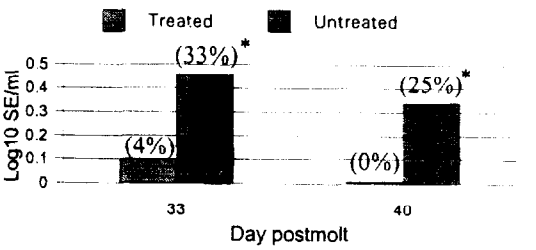
    - Cracked corn
- Antibiotic therapy
- Vaccination

Antibiotic therapy

- Molt birds via 14-day feed withdrawal
- Baytril administered in water (10 mg/kg) for next 10 days
- Aviguard competitive exclusion culture given at 24 & 72 hr post last Baytril dose
- Test birds for SE the next two weeks

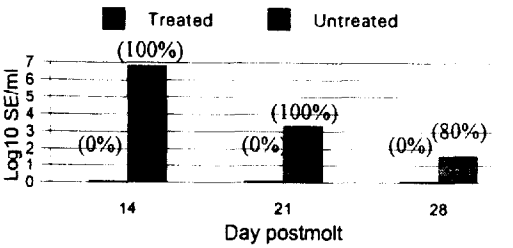
Baytril + AviGuard treatment on SE infection postmolt



Antibiotic therapy #2

- Molt birds via feed withdrawal
- On day 4 of feed withdrawal, Baytril administered in water (10 mg/kg) for 7 days
- Aviguard competitive exclusion culture given at 24 & 72 hr post last Baytril dose
- Test birds for SE the next two weeks

Baytril + AviGuard treatment during feed withdrawal on SE infection postmolt



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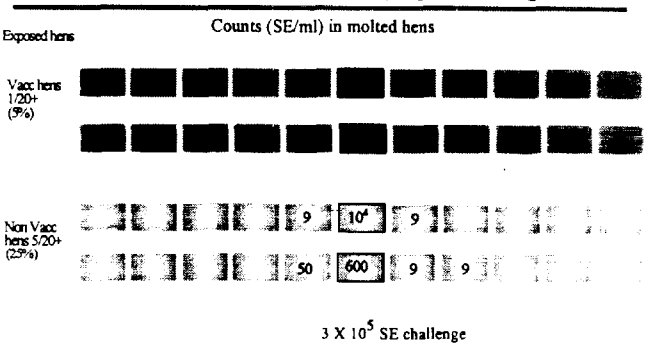
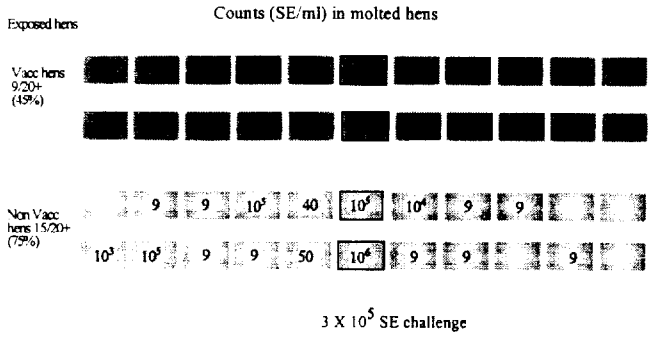
Quantitative counts of alimentary secretions of vaccinated vs unvaccinated exposed hens - day 3 post challenge

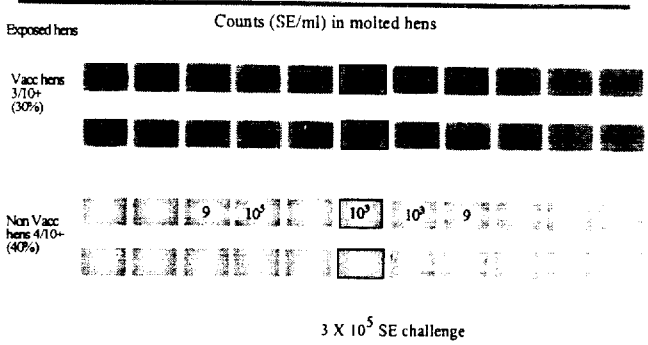


Quantitative counts of alimentary secretions of vaccinated vs unvaccinated exposed hens - day 10 post challenge



3 X 10^5 SE challenge

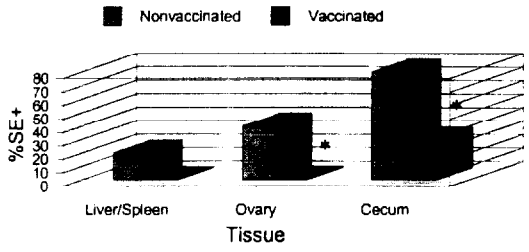
Quantitative counts of alimentary secretions of vaccinated vs unvaccinated exposed hens - day 17 post challenge



3 X 10^5 SE challenge

Percent positive organs in 10 contact exposed vaccinated or unvaccinated molted hens

Day 11 post challenge



Where do we go from here?

- More alternative molt studies
  - Other possible procedures
  - Determine ID50, pathology, etc
- Molt = stress? Examine stress parameters of feed withdrawal & alternative molt (USDA/ARS LBRU, Purdue University)
  - Neuroendocrine
  - Behavioral
- Examine molt vs SE in field

Molt and field studies

- Molting and SE in commercial birds
  - Culture flocks pre-, during, and post-molt
    - See if SE situations observed experimentally also occur in the field
    - Examine which molting procedures exert an effect
  - Bring in commercial birds and do experimental molt and SE infection
    - Tests whether exposure of hens in the field to different bacterial species, including *Salmonella*, might impact the progression of an SE infection during molt

House/flock characteristics during molt

- Molt procedure
- House capacity
- House age
- Flock age at molt (weeks)
- Vaccination status (SE)
- Cage density
- Manure handling
- Rodent & fly control/index
- Other *Salmonella*

Previous/current field studies on molting and SE

- SE Pilot Project
  - Increase in SE+ eggs first 5 weeks of molt
- NAHMS
  - Connect incidence of SE in houses with molting
  - Previous status of house unknown

National Animal Health Monitoring System (NAHMS)

- Estimate SE prevalence in US & evaluate potential risk factors for SE
- Describe baseline management and health practices used by US layer industry
- Describe industry quality assurance programs & their relationship to SE prevalence
- Identify biosecurity measures used by industry & evaluate their relationship to flock health & SE status

NAHMS & molting

Questionnaire

- Molt flocks? Age at 1st? 2nd? 3rd?
- Testing for SE routinely performed on farm? Pre &/or post molt?
- Molt type - feed restriction set #days or set weight loss; other method (specify)
- If feed restricted set #days - how many days?

Other stressors and *S. enteritidis*

- Disease
  - IBDV (Phillips & Opitz 1995)
  - Coccidia (Qin et al 1996)
- Environmental stress
  - Thermal
  - Crowding
  - Transport
- Intoxication

Vaccination and its role in protecting against *Salmonella enteritidis* infections in layer flocks

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Vaccination premise

Administer *Salmonella* organism to bird

↓

Bird generates immune response

↓

Bird protected against *Salmonella* infection

↓

Consuming public is safe

↓

Poultry industry is happy

Types of vaccines

- Live
  - *Attenuated to reduce infectiveness in host & also humans*
  - *Administered in water, feed, possibly aerosol*
- Inactivated
  - *Killed whole organism made up in an oil emulsion (generally)*
  - *Injected into bird*

Live *Salmonella* vaccines

Salmonella typhimurium

- Megan Vac (*Megan Health Inc., St. Louis, MO*)
  - Δ*cya* Δ*crp* mutant
- Zoosaloral H (*Impfstoffwerk Dessau-Tornau GmbH, Germany*)
- *Salmonella* vac T (*TAD Pharmazeutisches Werk GmbH, Germany*)

Salmonella gallinarum - 9R

Salmonella bacterins

- *Salmonella enteritidis*
  - Biomune - Lenexa, KS
    - *Layermune SE*
  - Maine Biological Laboratories - Waterville, ME
    - *Inacti/Vac SE4* - 4 phage types
    - *Inacti/Vac SE4-ND-IB2*
    - *Inacti/Vac Auto* - Autogenous bacterin
  - Fort Dodge Animal Health, Overland Park, KS
    - *Poulvac SE* - 3 phage types
    - *Poulvac SE-ND-IB*
- Other *Salmonella* serotypes

Protection by inactivated vaccines

- Reduced clinical signs & pathology
- Reduced shedding
- Reduced organ+
  - Livers & spleens
  - Ovaries
- Reduced +eggs
- Inhibition of growth in egg contents

Note: keyword = reduced, not cleared

Important to use along with other management practices

Inactivated vaccines - field

- Reduced flock incidence of infection
- Reduced environmental +
- Reduced incidence of + samples of replacement flocks put in C & D building
- Positive flocks, vaccinate, slowly become negative

Inactivated vaccines - England

- Vaccine produced by Hoechst
- Iron-starved *S. enteritidis*
- Vaccinate at hatch & when transferred to laying facility
- 30% drop in *S. enteritidis* cases 1998 - downward trend continues

Protection by live vaccines

- Reduced shedding
- Reduced organ+
  - Livers & spleens
  - Ovaries
- Reduced +eggs
- Cross protection against heterologous *Salmonella* serovars (vaccine variable)

Important to use along with other management practices

Future directions

- More live vaccines
- Mucosal vaccination
- In ovo vaccination
- Subunit/vectored vaccines
- DNA vaccines

Competitive exclusion and its role in protecting layer flocks against *Salmonella enteritidis* problems

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Competitive exclusion

- Nurmi & Rantala (1973) - control of *S. infantis* outbreak in broilers
  - Chicks lack intestinal flora 1st week
  - Administer intestinal contents from adult chickens
  - Flora "competes" with Salmonella for nutrients, niches, and binding sites
  - Flora also produce volatile fatty acids which inhibit growth of salmonellae
- Used effectively to prevent colonization of chicks with different salmonellae including *S. enteritidis*

Competitive exclusion and SE

- Can be very important in preventing colonization of newly hatched chicks
- Limited utility in adult birds
  - have well developed intestinal flora
  - used to reconstitute flora after antibiotic administration therapy

Competitive exclusion products

- Commercial
  - Pre-empt - Milk Specialties *
  - Aviguard - Bayer AG
  - Broilact - Farmos Orion
- Under development/licensing
  - Mucosal competitive exclusion (USDA/ARS PMS and Continental Grain)
  - Saccharomyces boulardii